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ABSTRACT

An interdisciplinary environmental education program was introduced on an experimental basis into high school social studies and science courses in an effort to produce competencies in environmental problem solving. Ninth and tenth grade classes in a suburban school district in Atlanta participated in the study. The ninth graders were of average reading ability, and the tenth graders were of low reading ability. Experimental materials included four interdisciplinary student modules (textbook, slides, audio tapes, and maps) and four teacher's guides. Ninth grade modules contained geography and biology content; tenth grade modules contained chemistry and American history content. There were four treatment groups in each grade: one studied an environmental module in science class only; one studied a module in social studies class only; one studied modules in both classes; and the control groups did not study the modules at all. Pre- and posttest results were analyzed to see if there was a significant difference of posttest performance among the four groups at each grade level. Although student groups which had the combined treatment in both grades produced the highest mean scores, the ninth grade students scored significantly higher than tenth grade students. This may be because the ninth graders were of average reading ability, whereas the tenth grade groups were noted to have reading difficulties. More research using the modules with slow learners is needed. (Author/AV)

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Cognitive Evaluation of Joint and Separate Social ıce Instruction in High School Environmental Educa

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Environmental Education for Secondary Schools (EESS)[1], a curriculum project at the University of Georgia in 1975-76, integrated environmental education into high school social studies and science courses in an effort to produce competencies in environmental problem solving which were grounded in the knowledge and skills of both subject areas. The program was based on an assertion that if students are to confront environmental issues, such as land use planning, energy use, pollution problems and waste disposal, intelligently and seek solutions analytically, their environmental education must be a cumulative process drawing from the fundamental knowledge and skills of their social studies and science courses over several years. The proposition that joint instruction will produce interdisciplinary problem-solving skills has been proffered by a number of educators in the environmental education literature of the early seventies (e.g., Dean, 1970; Stapp, 1972; Altman, 1972; Hepburn, 1973; Chalecki, 1974; Hepburn and Simpson, 1975; Kirman and Nay, 1975).

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The Gwinnett County School District, located in a rapidly growing suburban area of metro-Atlanta, was cooperator to the project, and its largest high school served as the pilot test site for the modular curriculum materials. County-wide school district resources were combined with university resources

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[1] Environmental Education for Secondary Schools curriculum development project was initiated in 1975-76 with support from a grant from the U. S. Office of Education. Project staff were drawn from the departments of Social Science Education and Science Education at the University of Georgia. Dr. Hepburn, Associate Professor of Social Science Education, served as project director.

to develop materials which focused on local issues while promoting broader, more universally applicable environmental knowledge.

Materials were prepared for integration into ninth and tenth grade science and social studies classes commonly offered in the school district (See Figure 1). The implementation design was based on the assumption that it would be more effective to attempt to generate interdisciplinary environmental education across existing departments and within the existing curricular framework than to attempt to change the departmental structure or expand the program of studies with several new courses. Joint-planning across departments was utilized to prepare a program which would be interdisciplinary in its consideration of the same environmental issues at each grade level but which would highlight information, useful skills and perspectives of the specific subject area in which the environmental module was taught. A total of four interdisciplinary student modules and four teacher's guides were produced. Each module included materials (textbook, slides, audio tapes, maps and supplemental informational booklets) for approximately 17 class days.

The coordinated instructional modules for ninth graders were prepared for use in geography and biology courses taught to the great majority of ninth grade students (i.e., those considered to be in the high-average to low-average range). These ninth grade materials focused on rapid population growth and the attendant issues of land use, waste recycling, and pollution. Their readibility level by the Dale-Chall formula was at ninth grade.

The tenth grade instructional modules were prepared, at the request of teachers in the school district, to meet a need for materials for "slow learners" (i.e., those low performers for whom special courses are offered.) Written materials for these tenth grade courses were at the seventh grade level on the Dale-Chall readibility test. These modules were prepared for

integration into the action chemistry course and the "a-level" American History course. The topical focus of the tenth grade materials was on water problems including water sources, usage, pollution problems, treatment methods and flood problems.

Research Design and Procedures

Test items were drawn up as the environmental modules were being developed. Two cognitive tests were prepared for each grade level -- a posttest and a shorter pretest. Since students were not randomly assigned to treatment groups, the pretest data were collected for covariate analysis which would adjust for effects on the posttest of differences in reading ability and environmental background knowledge that existed preceding the treatments (Borg and Gall, 1971, p. 394). For the ninth grade classes a 30-item pretest and a 46-item posttest were prepared. For the tenth grade classes a 30-item pretest and a 49-item posttest were prepared. Completely different items were contained in the pre and post tests. Both tests were based on the objectives and concepts of the modules, but the posttests were more subject-specific in that they called for more detailed application of the skills and knowledge taught in the modules. The tests items were interdisciplinary in that they drew from both science and social studies. Each test contained a balance of higher level and lower level cognitive items.

In the spring quarter of 1976 the newly developed instructional modules were taught to intact ninth and tenth grade social studies and science classes shown in Table 1. There were four treatment groups in each grade: some students studied an environmental module in science class only; some students studied an environmental module in social studies class only;

some studied environmental modules in both science and social studies classes; and some received no intentional environmental education instruction in either their science or social studies classes.

Two research questions were addressed:

1. Is there a significant difference of posttest performance among the four treatment groups a) in the ninth grade with students designated as "average," and b) in the tenth grade with students designated as "a-level" or slow learners.

2. If a significant difference is found among the treatment groups in either or both grades, which treatment group(s) account for the difference? (In particular, does the combined social studies and science treatment make a significant difference when compared to separate science or social studies treatments?)

To test for the first question, for each grade an analysis of covariance (ANCOVA) on posttest scores, using pretest scores as the covariate, was calculated for the four treatment groups. Means and standard deviations on both tests were calculated and adjusted posttest means were determined. Additionally, pretest and posttest reliability estimates were calculated using Cronbach's coefficient alpha.

In regard to question two, when a significant F-value was found in the ANCOVA, a post hoc analysis was applied. The Newman-Keuls' multiple range test of the adjusted treatment group means was used to determine if the distances between the means was at or above the critical level and thus significant. Because the number of cases in the four treatment groups was unequal, a harmonic mean of the case numbers was calculated before applying the Newman-Keuls' formula (Bruning and Kintz, 1977, p. 120).

Results

The ANCOVA of the test scores of the ninth grade students revealed the pretest to be a significant covariate at a level less than .001. The F-value from treatment effects was also significant at less than the .001 level. (See Table 2). The coefficient of realiability (Cronbach's alpha) on the pretest was .86, and the posttest reliability coefficient was .87 (See Table 4). Adjusted mean scores were highest for treatment group 3 second highest for treatment group 2, third highest for treatment group 1 and low for treatment group 4 (See Table 5).

The Newman-Keuls' post hoc analysis clarified sources of the significant difference in treatment group means. Group 3 which studied environmental modules in both science and social studies classes had a significantly higher mean than all other groups. Also treatment group 1 (science module only) and treatment group 2 (social studies only) were not significantly different from each other but were significantly different from group 4 which received no environmental education instruction (See Table 7).

The ANCOVA of the tenth grade test data revealed a treatment effect with an F-value significant at less than the .02 level (See Table 3). Here again, the pretest was found to be a highly significant covariate with an F-value significant at less than the .001 level. The adjusted treatment means were somewhat differently ordered (from high to low) than the ninth grade groups, with the highest mean resulting from the combined treatment (group 3), a very close second highest mean for treatment 1 (science only), the third highest mean from the control group and treatment 2 (social studies only) with the loweat adjusted mean (See Table 6).

The Newman-Keuls' post hoc analysis revealed that both group 3 (combined social studies and science instruction) and group 1 (science only) had means significantly different from group 4 (control). However, the mean for treatment group 3 was not significantly higher than group 2 (social studies only) althrough it was very close to the critical range.

Summary and Conclusions

Results of the study support the generalization that coordinated modular interdisciplinary environmental instruction offered in both social studies and science courses is more effective than the same type of instruction offered only in the science or in the social studies course. Student groups which had the combined treatment in both grades produced the highest post-test means. This is not at all surprising since these students were involved in environmental studies for two class periods of the day rather than one or none.

However, it was only in the ninth grade sample that the combined social studies and science treatment was significantly different from all other treatments and that the separate science and social studies treatments produced scores significantly higher than the control group. These average students, are generally considered to be able to read and perform at their grade level. The tenth grade students, on the other hand, were noted to have reading difficulties, and it would seem that the "double dose" of joint environmental instruction in both social studies and science courses would be especially effective for these students. But tenth grade treatment group 3 showed a significant difference from the control group only. The adjusted mean score for treatment group 3 was only .5 higher than group 1.

Most surprising was the slightly higher mean of treatment group 4 (the control group) over group 2 (social studies only).

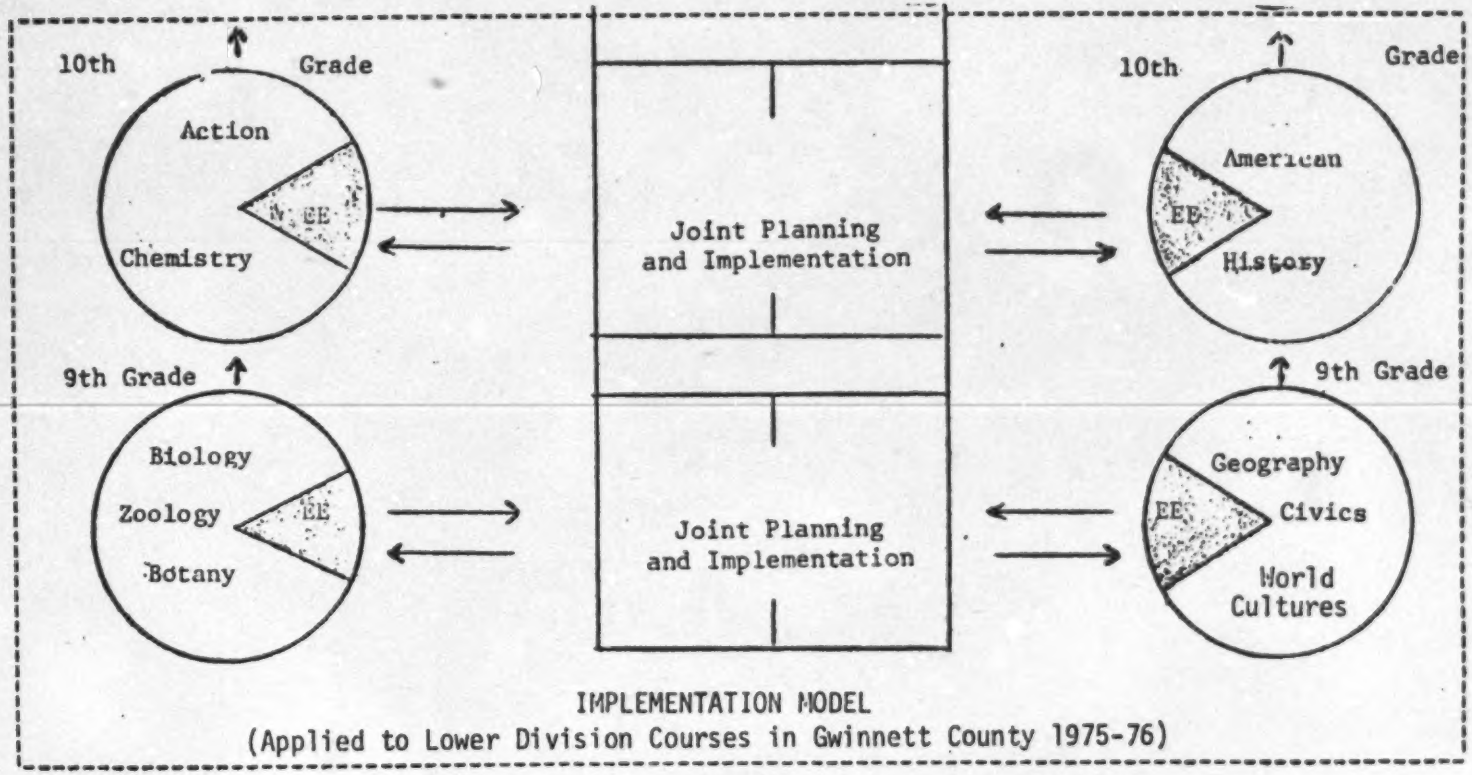
In an effort to better understand the tenth grade results, teachers' daily notations in their notebooks and several interviews conducted at the completion of the pilot tests were throughly reviewed. Both the social studies teacher and the science teacher who taught the slow learners were considered by the administration and their colleagues to be very effective with the slower students. They utilized numerous instructional approaches that actively involved students in field work or class projects, and in some cases added to or extended activities that were already built into the module. Discussions with the teachers provided us with additional comparative information about the class groups. It was learned that one of the two slow learner classes in treatment group 2 was considered to be a particularly difficult group to instruct because it contained mainly students who had been dropouts for a quarter or more. The teacher who taught them reported that they were very restless during the 49-item posttest, and some refused to complete it. Such differences in the social-intellectual makeup of one or more of the tenth grade classes may have biased the posttest score results in one or more treatment groups.

Another problem was that in the production of the tenth grade instructional materials and tests, the project staff was working under a very tight time schedule in the late spring. The tenth grade test development took place after the ninth grade development. Reflecting on the tenth grade posttest item analysis where only nine items had an item-test correlation of .30 or above (Pearson R point biserials), we are concerned not only about the reading difficulty of a number of the questions used on the tenth

grade posttest, but also that the test did not accurately test for the special instruction given.

In summary, although joint social studies and science instruction of environmental education modules appears from this study to have high potential for improving the environmental knowledge of average students. More research and test development must be done to better measure the potential of this model for environmental education with slow learners.

FIGURE 1



IMPLEMENTATION MODEL
(Applied to Lower Division Courses in Gwinnett County 1975-76)

TABLE 1

TEST DESIGN AND STUDENT AND CLASS NUMBERS

Ninth Grade

	T_1	T_2	T_3	T_4
EE Module Used	Science Only	Social Studies Only	Both	Neither
Subject	Biology	Geography	Biology & Geography	World History
Number of Classes	1	1	1	1
Number of Students	23	26	17	27

Tenth Grade

	T_1	T_2	T_3	T_4
EE Module Used	Science Only	Social Studies Only	Both	Neither
Subject	Action Chemistry	American History	Action Chem & American His.	Action Chemistry
Number of Classes	2	2	1	1
Number of Students	28	36	21	21

TABLE 2

ANALYSIS OF COVARIANCE OF NINTH GRADE COGNITIVE POSTTEST SCORES WITH PRETEST AS COVARIATE

Source	SS	DF	MS	F
Within Cells	1871.844	88	21.271	
Covariate	496.822	1	496.822	23.357*
Treatment	1161.017	3	387.006	18.194*

*$p < .001$

TABLE 3

ANALYSIS OF COVARIANCE OF TENTH GRADE COGNITIVE POSTTEST SCORES WITH PRETEST AS COVARIATE

Source	SS	DF	MS	F
Within Cells	1787.977	101	17.703	
Covariate	613.924	1	613.924	34.680*
Treatment	181.223	3	60.408	3.412**

*$p < .001$

**$p < .020$

TABLE 4

RELIABILITY ESTIMATES FOR COGNITIVE TESTS

USING CRONBACH'S COEFFICIENT ALPHA

GRADE	TEST	COEFFICIENT
Ninth	Pretest	0.864
	Posttest	0.876
Tenth	Pretest	0.652
	Posttest	0.789

TABLE 5

MEANS SCORES ON COGNITIVE ACHIEVEMENT OF FOUR TREATMENT GROUPS IN NINTH GRADE

Treatment Group	N	Pretest Mean (30 items)	Pretest SD	Posttest Mean (46 items)	Posttest SD	Posttest Mean Adjusted for Pretest as Covariate
Science Only	23	13.91	3.30	21.39	4.77	21.20
Social Studies Only	26	12.58	3.99	23.27	4.99	23.86
Science and Social Studies	17	15.12	4.26	29.00	5.65	28.11
Control (No Instruction)	27	13.33	4.55	17.82	5.32	17.97

TABLE 6

MEAN SCORES ON COGNITIVE ACHIEVEMENT OF FOUR TREATMENT GROUPS IN TENTH GRADE

Treatment Group	N	Pretest Mean (30 items)	Pretest SD	Posttest Mean (49 items)	Posttest SD	Posttest Mean Adjusted for Pretest as Covariate
Science Only	28	17.21	3.99	25.47	4.62	24.55
Social Studies Only	36	13.61	3.89	20.61	5.27	21.97
Science and Social Studies	21	17.00	3.96	25.81	4.63	25.03
Control (No Instruction)	21	16.29	3.65	22.43	4.60	22.09

TABLE 7

NEWMAN-KEULS' MULTIPLE RANGE TESTS ON
ADJUSTED POSTTEST MEANS FOR FOUR TREATMENT GROUPS

Ninth Grade

	T_4	T_1	T_2	T_3	r	$q.95r\sqrt{ms_e/\bar{n}}$
	17.97	21.20	23.86	28.11		$(r,85)\sqrt{ms_e/\bar{n}}$
T_4	———	3.23*	5.89*	10.14*	4	3.60
T_1		———	2.66	6.91*	3	3.28
T_2			———	4.25*	2	2.73

Tenth Grade

	T_2	T_4	T_1	T_3	r	$q.95r\sqrt{ms_e/\bar{n}}$
	21.97	22.09	24.55	25.03		$(r,96)\sqrt{ms_e/\bar{n}}$
T_2	———	.12	2.58	3.06	4	3.10
T_4		———	2.46*	2.94*	3	2.83
T_1			———	.48	2	2.36

* Significant at $p < .05$

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